ARCADA

ABC analysis in a company within the technical industry.

Case study for a Company

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Abstract:

The aim of the research is to help the client company to find out how they can optimize the inventory for selected products and still maintain a good customer service level. The client company is an electronic material wholesaler in Finland. The purpose of this research is to find out the products that are coming from the client company's manufacturer A and B are eligible to be put into the warehouse stock of should be produced on order. The method chosen for this research was the qualitative research method. With the qualitative research's characteristics, it does support this study competently. Thus, Bryman and Bell's steps of the qualitative method was implemented as this research primary method. As per the research's secondary data source, relevant studies, publications, and other scientific materials were also used. The gathered data primary and secondary, were evaluated from the writer's perspective and knowledge of business logistics. Results showed that there are number of products that can be put into the client company's warehouse. At the same time there are products that just makes sense to produce on order due to the factors of its sales amount and revenue, its physical nature, and manufacturing location. Data collection was conducted during the spring of 2022, and Finalized during the Autumn of 2022.

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The writer would like to extend a sincere appreciation to the ones who never stopped showing their support during the writing process of this thesis.

Again, Thank you!

1 INTRODUCTION

In an ideal world, materials should move continuously smooth in the supply chain. In reality, delay of material will always be present, and when materials stay at the same places, they form stock. Organizations hold stocks of some kind, stocks are sometimes for the customer to buy, or for the business to show the customer what a product looks like. (Waters 2003)

Working capital is largely consumed by inventory. Inventory management's major goal is to improve corporate profitability through better inventory management, predict the influence of corporate policies on inventory levels, and reduce total logistical costs while meeting customer needs. (Grant, D.B. 2006)

This research subject is chosen because there has been a problem identified and as the writer study International Business, the writer is assigned to do the study. It is decided that the writer will do ABC analysis and Turnover rate analysis to find solutions and improve logistical processes between the client company and its sister companies. By using these methods, the researcher is expected to be able to identify the critical products in terms of sales and stock and propose the optimal type of inventory control for the products.

The idea behind ABC analysis is that some products give more benefits to the company than others. The benefits of ABC analysis can be seen in sales, profitability, revenues, and many more factors that a company considers to be important. (Grant, D.B. 2006)

1.1 Problem statement

The client Company has a difficulty of managing the stock of the products that are coming from its sister companies. The difficulty is that they do not know the demand of each product. For this reason, it is hard for the client company to determine the performances of each product. Therefore, the client company cannot decide which products are to be made to stock and which products are to be manufactured on orders.

The client company has not done ABC analysis for this certain case; thus, it has been decided that the research will address that issue and produce solutions to recommend to the client company and impose to its operation.

1.2 Aim of the study

The aim of the research is to help the client company to find out how they can optimize the inventory for selected products and still maintain a good customer service level. The researcher will use ABC analysis and Double ABC analysis to be able to find out the expected result of the research.

The client company wants to find out which is more economically cost efficient; Either to stock the products in the warehouse or to do a manufacture to order system, or somewhere in between. In this way they can make some adjustments in their operation towards efficiency.

These are the main questions that the research is aiming to get answers to:

- o   What products should be kept in the warehouse?
- o   What products should be produced on order?

1.3 Demarcation

The client company has a vast selection of products in their warehouse. With a few manufacturer/ producer companies they import or buy their stocks from, this thesis will only focus on the products coming from their sister companies and will include only limited product range.

The data will be gathered only from the year 2021. Turnover rate analysis will be included in the data gathering.

1.4 Definitions

1.4.1 ABC analysis

"ABC analysis is used to categorize items into three classifications, based on activity levels. The concept is most commonly applied to inventory, where the "A" classification identifies high-usage items, the "B" classification identifies medium-usage items, and the "C" classification identifies low-usage items." (Bragg 2021)

1.4.2 Inventory

Inventory is another term for materials, and it refers to any material that a company keeps on hand to meet customer demand (which can be internal or external to the company). Inventory can thus be found at multiple points along the supply chain, including the supplier, the factory, and the customer's location. (Mangan, Lalwanis and Calatayud 2020)

1.4.3 Make to stock (MTS)

Make-to-stock (MTS) is a manufacturing technique in which production planning and scheduling is based on product demand forecasts. Products created during one manufacturing cycle are utilized to meet orders placed during the next. This means that production is initiated prior to and independent of client orders in make-to-stock production planning. (Siemens Software 2022)

1.4.4 Make to Order (MTO)

(HAYES and JAMES 2020) States that make to order (MTO), sometimes known as made-to-order, is a corporate manufacturing approach that allows customers to buy products that are tailored to their individual needs. It is a manufacturing method in which a product's production begins only once a client order has been confirmed.

1.5 Presentation of the company

The client company is a wholesaler and as well an agency for some producer with the focus of offering services to the electrotechnical field. The client company offers a wide range of products from raw materials, insulation and non-insulation materials, Chemicals, resins, varnishes, and cables. The focus market target of the client company is for everything that has to do with building, repairing, and testing electrical motors, generators, and transformers. This research will be focused on the logistical flow between the client and its sister companies; A and B.

2 TEORI / THEORY

This chapter delves into the theories that lead to recommendations, suggestions, and outcomes for this study. The writer included a variety of theories relevant to the research in this chapter. The author used the Pareto principle to introduce ABC analysis. ABC analysis is important because it is the main theory of the study and will aid in the resolution of the study questions. Finally, delivery service is included because it is important for the client company to have better stock availability in which can result to better lead time.

2.1 Inventory Management

The process of ordering, storing, using, and selling a company's inventory is referred to as inventory management. This comprises the storage and processing of raw materials, components, and completed products, as well as the administration of raw materials, components, and final products. (Hayes, 2021) Inventory management's goal is to give the most cost-effective solution to end users and suppliers in the supply chain. Because there is no endless warehouse space supplied with client company, one of the primary development aspects is to avoid surplus inventory. All of this necessitates having the proper quantity of products in store while minimizing inventory costs. (Hayes, 2021)

2.1.1 Cost of inventory

Carrying costs, ordering costs, and stock out cost are the three primary expenses associated with inventory management, according to (Murphy and Knemeyer 2017). The

expenses of keeping inventory, often known as inventory carrying (holding) costs, are a major source of worry. Carrying costs include a variety of expenses ranging from storage to insurance. Carrying costs are expressed as a percentage of inventory value. Ordering costs are the costs involved with ordering merchandise, such as order costs and setup costs. Order expenses include, but are not limited to, the costs of receiving an order, doing a credit check, checking inventory availability, putting orders into the system, producing bills, and receiving payment. Stock out cost arise when supplies are depleted. These expenses are difficult to measure since they might include penalties, lost revenues, and client loss. (Murphy and Knemeyer 2017)

2.1.2 Stock Turnover ratio

According to (Muller, M. 2018) The inventory turnover ratio calculates how often inventory is replaced on average during a certain period of time. In its most basic form, an inventory turn occurs whenever an item is acquired, utilized, or sold, and then replaced. Two spins per year would be if an SKU came in twice during the year, was used/sold, and then refilled. It would take twelve spins every year if this happened once a month, and so on. Goods turnover is an essential metric since the company's capacity to transfer inventory rapidly has a direct influence on its liquidity. The following formula is used to determine inventory turnover:

Inventory Turnover Ratio = Cost of Goods Sold ÷ Average Inventory

2.1.3 Safety Stock

Safety stock, also known as buffer stock, is inventory held in case of unforeseen issues that result in insufficient inventory being available to meet demand. It enables organizations to better deal with lead time variations, production variations, and demand variations. The amount of safety stock a company should keep is determined by the level of service it wants to provide to its customers (and these can be both internal and external customers). There is a trade-off between the cost of holding excess stock and the cost of losing sales – and thus customers – because of shortages or backlogs of unfulfilled orders. (Mangan, Lalwanis and Calatayud 2020)

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2.2 Pareto principle

Vilfredo Pareto, an Italian economist, discovered in 1906 that only 20% of the people in Italy owned 80 percent of the land. He continued his research and discovered that the disproportionate wealth distribution was consistent throughout Europe. The formal definition of the 80-20 rule is as follows: the top 20% of a country's population accounts for an estimated 80% of the country's wealth or total income. (Kenton 2021)

Pareto analysis is a method used in business decision-making, but it also has applications in welfare economics and quality control. It is largely based on the "80-20 rule." Pareto analysis, as a decision-making method, statistically separates a small number of input factors—either desirable or undesirable—that have the greatest impact on an overall result. (Kenton 2021)

Pareto analysis is based on the idea that doing 20% of the work can yield 80% of the benefit of a project, or that 80% of problems can be traced back to 20% of the causes. Pareto analysis is an extremely effective quality and decision-making tool. In the broadest sense, it is a method for gathering the information needed to set priorities. (Kenton 2021)

2.3 ABC analysis

"The ABC Analysis is based on the Pareto principle (also called the 80/20 rule), which states that about 80% of the effects come from about 20% of the causes. In terms of inventory management, the Pareto principle can be declared as 20% of inventory items by type account for 80% of annual consumption value." (Smirnov 2018)

ABC analysis is a technique for categorizing items, events, or activities based on their relative importance. It is commonly used in inventory management to categorize stock items into categories based on the overall annual spending or cumulative stockholding cost of each item. Organizations can devote more time and effort to high-value and prominent issues. (Ims-productivity 2021)
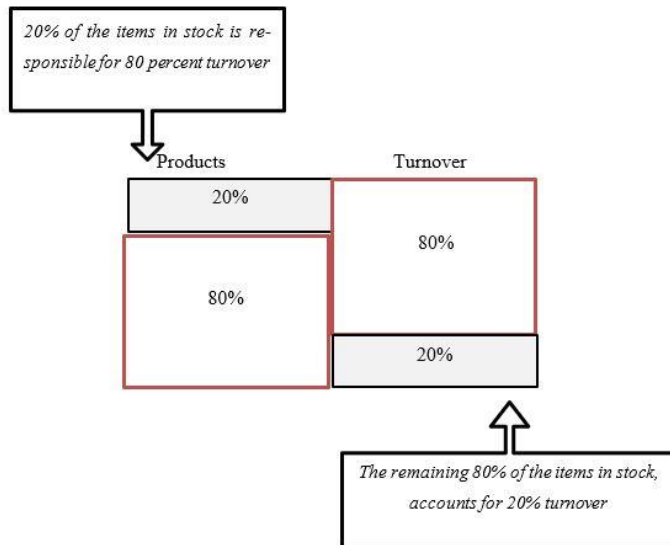
Figure 1. 80/20 rule. (Smirnov 2018)

2.3.1 ABC analysis categories

The most significant merchandise in the warehouse is those in category A. These are the products that make up a significant portion of a company's revenue. These products do not need a lot of effort and are the smallest category in your inventory, but they bring in the highest revenue. These items typically make up 20% of the company's inventory and account for roughly 80% of sales revenue. (Luenendonk 2021)

As a result, it is only natural that evaluation and monitoring of this class be particularly intense, given the highest potential for cost or loss reduction.

The middle of the product line is represented by Category B items. These items account for 30% of your inventory and 15% of your sales revenue. These goods are frequently disregarded by management, although they offer a lot of potential. These B items can be converted into profitable A products with a little work and attention. (Luenendonk 2021)

Products in category C are those that do not generate a lot of revenue on their own. These items sell quickly and provide minimal profit for the company. This accounts for over 50% of a company's inventory while only bringing in about 10% of sales revenue. These goods require the least level of supervision. (Luenendonk 2021). Tight inventory controls are usually not cost-effective to implement because the worth at risk of significant loss is low and the cost of analysis would typically produce low returns.
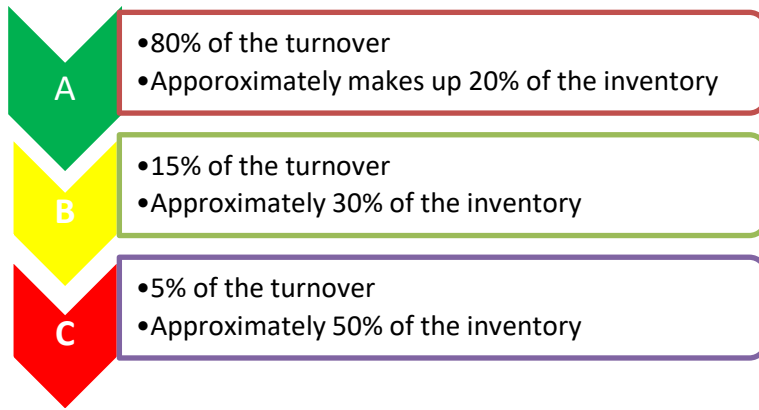
Figure 2. Single ABC analysis

It becomes much easier to concentrate on the data once the enormous amount of data has been broken down into A, B, and C categories. This is advantageous because businesses can use the data to turn it into something useful and design plans that are specific to each product category.

2.3.2 Advantages of ABC analysis

The Advantages of ABC analysis is as follows according to (Smirnov 2018.); Working capital requirements are reduced. Inventory item categorization allows the management to concentrate on the most valuable elements. The reduction of current assets and, as a result, the need for working capital is reduced when category A products are optimized. Additionally, better inventory management. Inventory management can be enhanced with a slight increase in cost by concentrating attention on the most important items. It also aids in the avoidance of overstocking and inventory deficiencies. Lastly, Cost-reducing. Inventory optimization reduces ordering and holding expenses, as well as losses due to inventory shortages. As a result of the lower working capital requirements, interest costs are reduced.

2.3.3 Disadvantages of ABC analysis

The majority of factors are ignored. The ABC analysis assumes that the measure will only be used for inventory item categorization and annual consumption value calculation. Other considerations are not considered. (Smirnov2018)

Inventory items are categorized in an arbitrary manner. The empirical approach of inventory categorization relies on the inventory manager's professional opinion rather than setting fixed category boundaries. As a result, caused by incorrect assessment, the accuracy of ABC analysis may be reduced. (Smirnov 2018)

For some organizations, there are restrictions on how they can use it. Organizations with an equal yearly consumption value of inventory goods by type cannot apply ABC analysis. In such instances, utilizing the Pareto principle to separate inventory items becomes impractical. (Smirnov 2018)

Season trends, such as holidays and weather, may also have an impact on the ranking of some products. Coats and sweaters, for example, may be classified as an A item during the winter season but demoted to the C rank during the summer. As a result, classifications will evolve and change over time. (Truong 2021)

The ABC analysis uses sales metrics to determine which level a product belongs in the model. However, because there will be no historical sales data to examine, it will be difficult to classify new products. (Truong 2021)

2.3.4 Double ABC Analysis

There are some issues that can arise when using the simple ABC analysis. The issue in is that the product's sales frequency is not considered. For example, a product can have the same volume value whether it is sold evenly throughout the year in e.g., 100pcs / month or in two batches at 6000 pcs / month. A product sold frequently has completely different opportunities for effective control than one sold in two, for example, rounds. To avoid problems like this, you can add a second dimension to the product classification. In this case, you could use sales frequency or any other frequency measure, such as withdrawal frequency or product margin. This is known as double ABC analysis. (Rudberg 2016)

Suppose the chosen sales revenue and profit margin as the analysis's metrics. The AA class includes products with a high income and one of the highest profit margins. The CC

class is the opposite, with low income and a low profit margin. The CC class can then indicate that these products are not sold on a regular or frequent basis. This method also allows for the combination of different classes. The AC class has products with a high income but a low profit margin, whereas the CA class has products with a low income but a high profit margin. (Rudberg 2016)
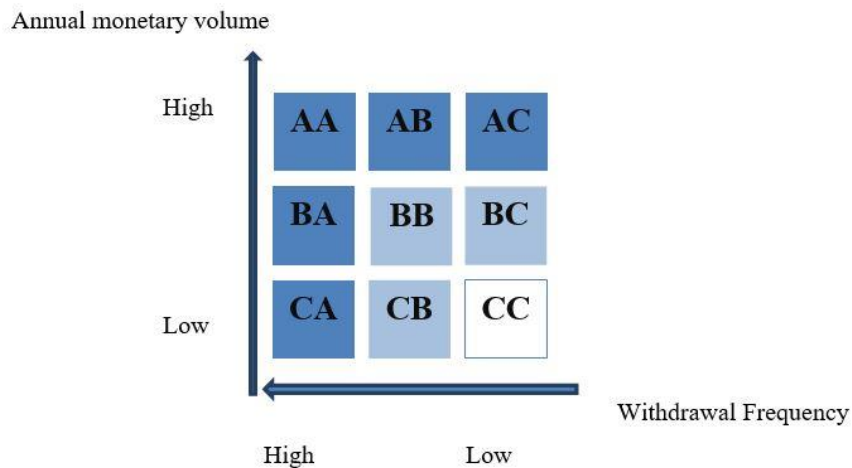
Figure 3. Double ABC analysis (Rudberg 2016)

2.3.5 Stock Control within the ABC analysis

According to Baily, P. et al., 2015, Stock is often kept in a subsidiary rather than a central position by organizations like some manufacturers, hospitals, and other service providers, but it is still a crucial component in operational efficiency and frequently shows up on the balance sheet as the largest of current assets, locking up a lot of money.

Baily, P. et al., 2015, additionally stated that constructive approach to reduction of stock includes; arrangements of products to be manufactured and delivered just in time instead of having the products laying around just for when it is needed. Furthermore developing a system to further reduce order cost, set up cost and lead times to have smaller ideal amount of products in stocks. Lastly, better planning, forecasting accurately and making sure that there is right records noted down.

2.4 Delivery Service

A supplier's logistical performance during a delivery to a customer is measured by the delivery Service. Both the provider and the customer keep track of these variables. A seller requires the information to improve their business and is not reliant on the information gathered by the buyer (there may be differences). A buyer requires information to assess the seller's performance. (Storhagen 2011)

The importance of delivery service in this research stems from the company's desire to keep stocks low while also providing good delivery service. Delivery service is related to ABC analysis because using ABC analysis allows the company to determine which products are more important than others, resulting in efficient warehousing and delivery service.

2.4.1 Delivery Capacity Indicator

According to (Storhagen 2011), there are total of nine significant indicators are used to assess a supplier's capability to carry out during delivery to a customer.

Stock Availability denotes the availability of a product. The likelihood that a product will always be available. Around 97 percent probability that the goods is in stock and can be delivered right away. If the product is not accessible when the consumer wants it, the order or even the customer may be lost.

The second Indicator covers *Lead Time and Delivery Time*. The term "lead time" refers to the time it takes for an order to be processed and delivered from the time it is confirmed. The time when an order is ready for delivery or when it arrives at the customer is referred to as delivery time. It is critical to go over how each supplier and customer define lead time and delivery time with them. It is crucial to discuss how each supplier and consumer define delivery and lead times. Customers and suppliers will be able to communicate more effectively as a result.

The *delivery reliability* is that of time dependability, that is, if the transport reaches at the agreed-upon time. When it comes to delivery time reliability, the goal should always be 100 percent efficient. When delivery time efficiency falls below 98 percent, it is considered a critical point. The number of deliveries of what would be delivered and the value of the deliveries of the total value to be delivered could be used as units of measurement. It is crucial to follow-up on the length of the delays by investigating the customer's complaints so that similar errors can be avoided in the future.

Delivery precision means that right products must be delivered in the right quantity; that is, the delivery must include exactly what the buyer purchased. Having faulty or broken items will elicit a strong reaction from the customer. The consumer will certainly file a claim, therefore it is critical to investigate why the wrong item or amount was shipped, as well as how the problem was resolved.

Information, it is important that information exchange between the concerning parties, the supplier and the customer go both ways. The information that includes follow up of the shipment and keeping the customer updated regarding the information of the purchased good's delivery is vital.

Customization, the capability to fulfill the demands of customers. To be able to prove to the customers that a supplier has what it takes to produce good delivery services, having to squeeze in a few adjustments when needed by the customer is necessary.

Choosing an *environmentally friendly option* for transportation, packaging, and warehousing method, for example, is an environmentally beneficial decision. To be able to compete and strive in the ever-changing business world and to take care of the environment, a company should think about its methods and think sustainably. This way, attracting customers that have the same value will not be so difficult.

Flexibility, Malleability to the changing circumstances.

3 METHOD

3.1 Research approach

Discussions with the client company's managers pointed out that to conduct the ABC analysis, the writer would need to collect the following data; turnover rate per product and amount sold per product, ABC analysis of the various sales amount and sales revenue from companies A and B.

Data collection using the client company's ERP system Visma Nova is conducted to determine what appropriate data the researcher needs, it is then decided that data such as sales revenue and sales amount or other data, are required to carry out the ABC analysis. This is the same data that would serve as the basis for a Double ABC analysis. The results of these analyses would then be used to perform an ABC analysis on stock optimization and warehouse stocking; products that will be stocked or should be produced on demand.

3.2 Choice of method

The chapter that follows discusses the qualitative research that is conducted for this thesis and how it is done. To proceed, a concise overview of the background of this research is provided, followed by a discussion and evaluation of the chosen method. As the purpose of this research is to determine what client company may do to improve its logistical operations to run a more efficient system, the writer of the case study sees himself as someone who has worked with client company business as an employee, and the qualitative research technique was utilized to conduct this study. Qualitative research is defined by Bryman (2011, p.386) "a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data".

3.2.1 Case study method

Because of the qualitative nature of the research objective, the case study method is appropriate for this topic: the primary goal is to perform an in-depth analysis on data directly relating to an individual case. According to Bryman and Bell (2015), the case study

method differs from other research methods in that the focus in a case study is on a detailed, in-depth inquiry of a specific situation. The case study research technique is also defined by Yin (1984) "as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used.".

There are five techniques used in gathering data when doing a case study method, these are observations, interviews, secondary data, documents, and records.
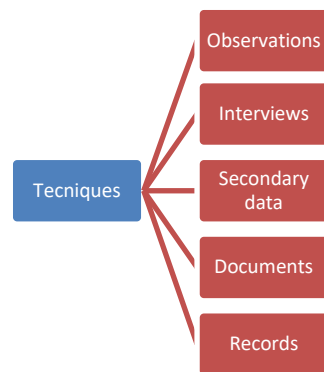
Figure 4. Techniques used to gather data for a case study

3.2.2 Qualitative research approach

The qualitative research approach was used for this study because it focuses on words rather than numbers. Qualitative method is used in this study for its research because of two reasons: The study scope only is limited to the client company's warehouse and nowhere else. Because there is no other warehouse to match up the results to, this research will remain focused on understanding the secondary data, which is exclusively a qualitative method.

There are six steps must be followed to conduct qualitative research as shown in the figure bel according to Bryman and Bell (2015); General research question is the initial stage in identifying the researcher's concerns. The researcher might then formulate questions to be answered by the research. Selecting the relevant sites and subjects. This phase entails selecting a subject that is related to the study's goal. Collection of relevant data. To obtain the relevant data for this stage, one would use a suitable research approach. Using numerous sources of data, such as interviews, observation, and so on, would be valuable.

Interpretation of data. This stage entails analyzing the data and looking for meaningful patterns. Conceptual and Theoretical work. At this stage, the researcher would combine the theory with the data gathered. The research questions should be defined more precisely. Further data collection. It is a clever idea to assess the acquired data at this point in the research process and then build finer, more precisely adjusted research questions from there. After then, more information can be gathered from relevant questions, and then look back on the step IV. Conclusions and findings must be written up. The last step is for the researcher to compile all the findings into a report.
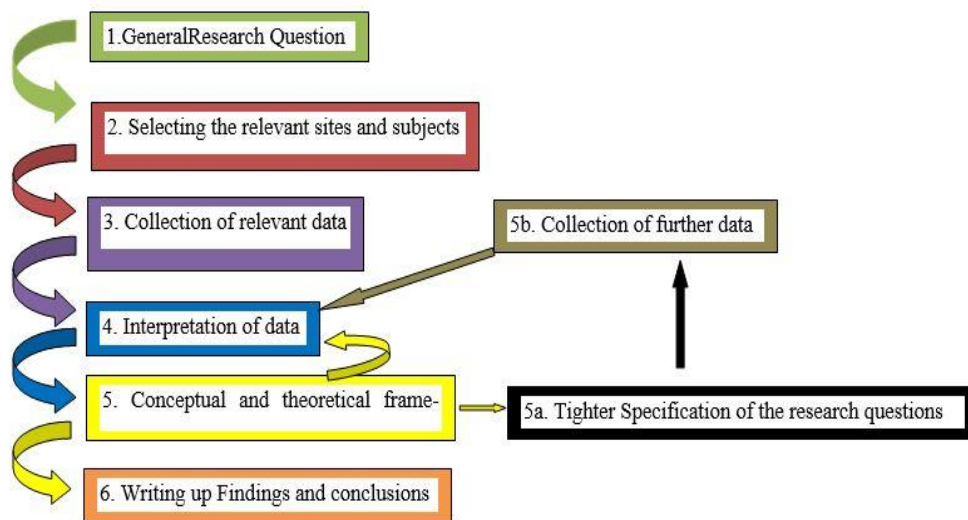
Figure 5. Six steps must be followed to conduct qualitative research Bryman and Bell (2015)

3.2.3 Collection of the data

In line with the Case study approach, one set of data is based on the writer's observation and information gathered throughout his experience working at the client company. Because the ABC analysis data was available for export from the client company's ERP system Visma nova, they serve as documents and record data in this research, the author intended to use it to run double ABC analysis as part of the study to obtain useful results.

The researcher used the Microsoft Excel look up tool to link the specified numbers and categories to create a double ABC analysis by integrating the ABC analysis data, such as sales quantity and sales revenue, with their respective companies, A and B. Using the lookup function in Microsoft Excel, this step is completed by matching the product code

from the sales amount and sales revenue. Using the P lookup tool in Microsoft Excel, the researcher next extracts and integrates the existing ABC analysis data from the given sales revenue and sales amount. The writer can use this approach to create exact double ABC analysis data.

3.3 Analysis of data

The study is undertaken to identify issues that are present in the coordination of items arriving from companies A and B, having acquired data using the research method mentioned earlier. The study's major purpose is to identify the supply chain's feasible improvement factors, based on the data uncovered while performing the research using the methodologies mentioned previously.

On the next points, the researcher briefly shows the approaches and steps taken for analyzing the gathered data to produce the desired results for this research.

3.3.1 Pareto Analysis on sales revenue and sales amount

The ABC analysis data was given by the client company in the form of an excel file directly extracted from their ERP system. The next step was to find out how to sort the data into a useable excel file and extract a pareto graph from the ABC analysis to better understand which products create the most sales revenue and sales amount. The writer used the count if function in Microsoft Excel to sort both ABC analysis from sales amount and sales revenue using the principle 80/20 pareto rule. As a result, the author has demonstrated that 20% of the items account for 80% of the income, as stated above in the theoretical chapters. Below are the Pareto analyses from the company B's sales revenue and sales amount.

	Amount	% Of revenue	% of products
A	39	80%	23.6 %
B	51	15%	30.9 %
C	75	5%	45.5 %
Total products	165		

ABC	% of revenue	% of products
A	80%	23.6 %
B	15%	30.9 %
C	5%	45.5 %
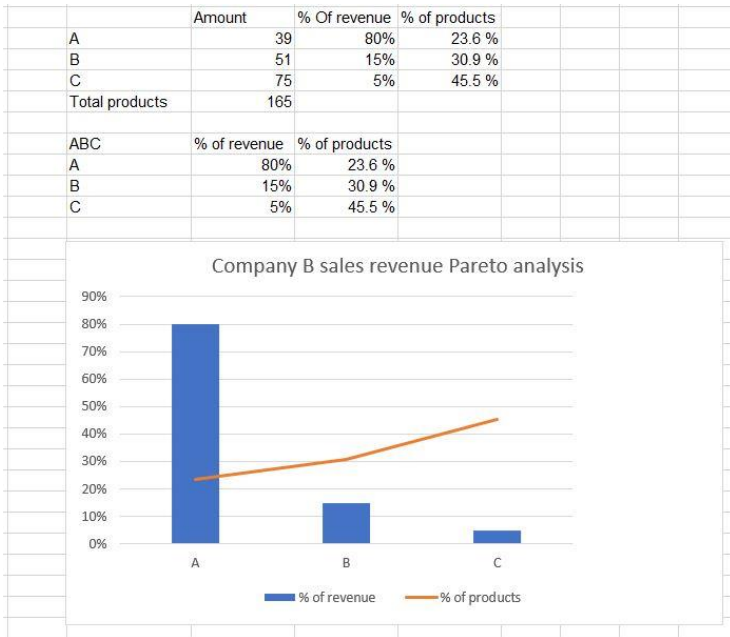
Figure 6. Sample Pareto analysis result for data analysis

3.3.2 Double ABC analysis

The researcher utilized the Microsoft Excel look up tool to link the selected numbers and categories to construct a double ABC analysis by combining the ABC analysis data such as sales quantity and sales revenue to their respected companies, company A and B. This procedure is accomplished by matching the product code from the sales amount and sales revenue using the lookup function in Microsoft Excel. The researcher next obtains and merges the existing ABC analysis data from the stated sales revenue and sales amount using the P lookup function in Microsoft Excel. This procedure allows the writer to generate the precise double ABC analysis data displayed in the figures below.

Table 1 Sample Double ABC analysis result for data analysis

	Amount of products		Amount of products		Amount of products
AA	9	AB	11	AC	19
BA	9	BB	8	BC	34
CA	1	CB	8	CC	66

3.4 Validity and reliability

Because the data collected in this research was restricted to the client company's sister firms A and B, the author draws no conclusions about the client company's overall functioning and not to generalize the outcome as it is not applicable to other companies. The data is gathered from the client's ERP system database, which contains outcomes from their activities as well as any other pertinent data. The author and the client company agreed on which information would be utilized or exposed throughout this thesis, along with all the data being treated with the utmost respect.

4 RESULTS

The result of the previously discussed methods is covered in this chapter. The results of this thesis were obtained by collecting the ABC analysis of the sales revenue and sales amount of the client company and its sister companies A and B. Once the findings of these two ABC analyses were discovered, the Double ABC analysis could be created and used to produce the desired outcome of this research answering the fundamental research questions; *What products should be kept in the warehouse?* And *What products should be produced on order?*

4.1 Company B Results

4.1.1 Company B Sales revenue results

The top products that generated the highest revenue in the year 2021 for companies B is shown in the table below. These items are part of the "A" category, which implies that they account for 80% of total sales revenue. This was accomplished by following the processes outlined in the third chapter on methodology in the quantitative research approach, which included data collection. Using the client company's ERP System, the writer managed to extract the exact ABC analyses desired for the research.

Table 2. Company B A listers sales revenue

Code	ABC	Percentage %	Cumulative %
1020221094	A	35.45	35.45
1020226031	A	6.80	42.25
1020220133	A	3.76	46.01
1020244034	A	3.25	49.26
1020220136	A	1.82	51.08
1020241251	A	1.61	52.69
1020244049	A	1.60	54.28
1020221003	A	1.46	55.74
1020224015	A	1.44	57.17
1020244039	A	1.37	58.55
1020222030	A	1.21	59.76
1020244021	A	1.19	60.95
1020220102	A	1.12	62.07
1020221071	A	1.06	63.13
1102231205	A	0.97	64.10
1020228005	A	0.95	65.05
1020224028	A	0.92	65.97
1020244058	A	0.86	66.82
1020208012	A	0.84	67.66
1020220070	A	0.84	68.50
1020244009	A	0.75	69.25
1020224012	A	0.71	69.97
1020220079	A	0.71	70.67
1020244004	A	0.69	71.37
1020244020	A	0.66	72.03
1020221068	A	0.66	72.68
1020220099	A	0.64	73.33
1020208009	A	0.62	73.95
1020221086	A	0.61	74.55
1020221024	A	0.58	75.14
1020220084	A	0.58	75.72
1020226030	A	0.57	76.29
1020222059	A	0.57	76.86
1102231100	A	0.55	77.40
1020221079	A	0.53	77.93
1020214154	A	0.53	78.46
1102231005	A	0.51	78.97
1020221082	A	0.51	79.48
1020241409	A	0.51	79.99

4.1.2 Company B ABC analysis data sales revenue

A
- 39 Products
- 80% of the sales revenue
- Apporoximately makes up 23.6% of the inventory

B
- 51 Products
- 15% of the sales revenue
- Approximately 30.9% of the inventory

C
- 75 Products
- 5% of the revenue
- Approximately 45.5% of the inventory
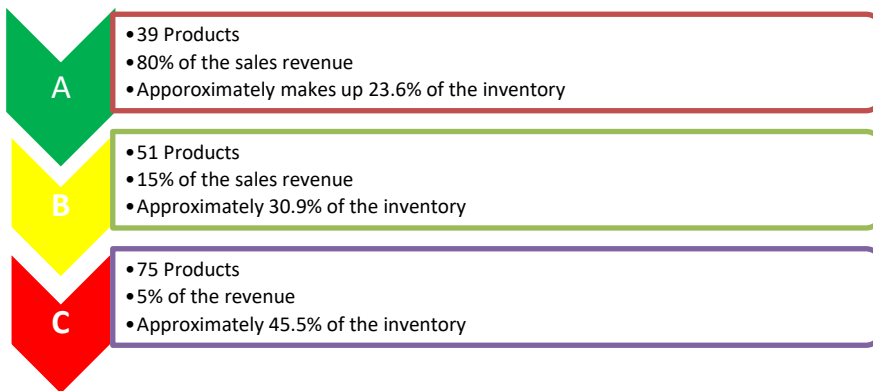
Figure 7. Company B ABC analysis data sales revenue

According to the ABC analysis data, Company B sold a total of 165 products to the client company during the year 2021. A total of 39 products falls into the A category, which accounts for 80% of total sales revenue and 23.6 percent of inventory. There are 51 goods in the B category, which accounts for 15% of sales revenue and 30,9% of inventory. Finally, 75 products fall into the C category, which generates 5% of revenue and accounts for 45.5% of inventory.

4.1.3 Company B sales amount result

The top products that generated the highest sales amount in the year 2021 for company B are displayed in the table below, like the sales revenue results above. These goods are in the "A" category, which means that they account for 80% of total sales. Again, the writer was able to extract the precise ABC analyses necessary for the study by following the methods mentioned in the third chapter on methodology in the qualitative research technique, which comprised data collecting, and by utilizing the client company's ERP System.

Table 3. Company B A listers sales amount

Code	ABC	Percentage %	Cumulative %
1020221071	A	10.57	10.57
1020208012	A	9.86	20.43
1020208009	A	8.45	28.89
1020221003	A	7.05	35.93
1020221053	A	7.05	42.98
1020221052	A	7.05	50.02
1020221024	A	5.28	55.31
1020221094	A	4.93	60.24
1020221079	A	3.17	63.41
1020221088	A	2.82	66.23
1020221086	A	2.11	68.34
1020210013	A	1.93	70.27
1020221077	A	1.59	71.86
1020208044	A	1.41	73.26
1020221091	A	1.41	74.67
1020210015	A	1.38	76.05
1020210016	A	1.27	77.32
1020221068	A	1.20	78.52
1020210014	A	1.19	79.71

4.1.4 Company B ABC analysis data sales amount

A
- 19
- 80% of the sales amount
- Apporoximately makes up 11,5% of the inventory

B
- 27
- 15% of the sales amount
- Approximately 16,4% of the inventory

C
- 119
- 5% of the amount
- Approximately 72,1% of the inventory
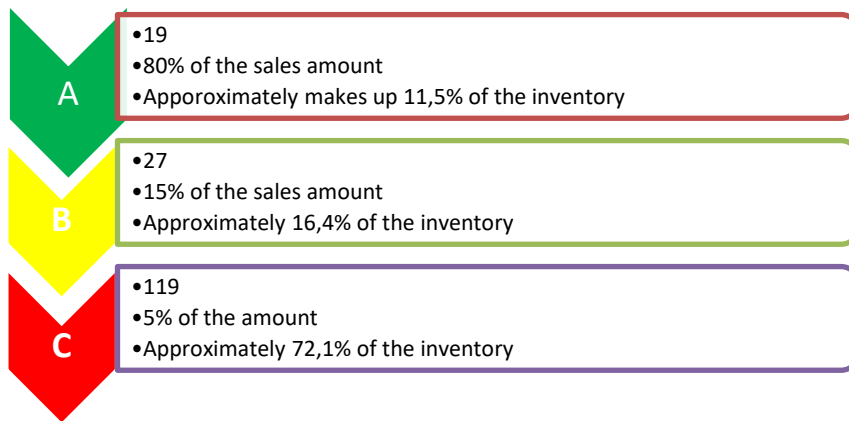
Figure 8. Company B ABC analysis data sales amount

According to the ABC analysis data and as mentioned earlier, Company sold a total of 165 products to the client company in 2021. The A category has a total of 19 goods, accounting for 80% of total sales amount and 11.5 percent of inventory. The B category has 27 products, accounting for 15% of total sales amount and 16.4% of inventories. Finally, 119 goods fall into the C category, which generates 5% of the total sales amount and accounts for 71% of the inventory.

4.1.5 Double ABC analysis result

The table below lists the 9 most popular and highest-earning goods in the "AA" category. Because financial information is sensitive, it has been hidden. These findings were obtained by following the methods outlined in the third chapter on methodology. They were as follows: data collection, determining the items with large sales amounts, calculating their percentage, sales revenue calculations, and categorizing the products into the "AA" categories and so following Rudberg's double ABC analysis theory discussed in the theory chapters.

Table 4. Company B AA listers

Code	ABC revenue	Percentage %	Cumulative %	ABC amount	Percentage %	Cumulative %	
1020221094	A	35.45	35.45	A	4.93	60.24	AA
1020221003	A	1.46	55.74	A	7.05	35.93	AA
1020221071	A	1.06	63.13	A	10.57	10.57	AA
1020208012	A	0.84	67.66	A	9.86	20.43	AA
1020221068	A	0.66	72.68	A	1.20	78.52	AA
1020208009	A	0.62	73.95	A	8.45	28.89	AA
1020221086	A	0.61	74.55	A	2.11	68.34	AA
1020221024	A	0.58	75.14	A	5.28	55.31	AA
1020221079	A	0.53	77.93	A	3.17	63.41	AA

4.1.6   Double ABC analysis result company B

Table 5. Double ABC analysis result company B

AA	9	High revenue High Sales amount
AB	11	High Revenue, Moderate Sales amount
AC	19	High Revenue, Low Sales amount
BA	9	Moderate Revenue, High Sales amount
CA	1	Low Revenue, High sales amount
BB	8	Moderate Revenue, Moderate Sales amount
BC	34	Moderate Revenue, Low sales amount
CB	8	Low Revenue, Moderate sales amount
CC	66	Low Revenue, Low Sales amount

The table above displays the nine double ABC classifications, followed by the number of products inside each classification, with AA having the highest sales revenue and the largest sales amount, and CC having the low revenue and sales amount. After obtaining this information, it was feasible to show to the client company which items may be maintained in the warehouse for stock and which products might be put on MTO.

4.2 Company A results

4.2.1 Company A sales revenue

The top products that generated the highest revenue in the year 2021 for company B is shown in the table below. Again, these items are part of the "A" category, which implies

that they account for 80% of total sales revenue. And was again accomplished by following the processes outlined in the third chapter on methodology in the qualitative research approach, which included data collection. Using the client company's ERP System, the writer managed to extract the exact ABC analyses desired for the research.

Table 6. Company A "A" sales revenue Listers

Code	ABC	Percentage %	Cumulative %
1050500014	A	6.3 %	6.3 %
1020241010	A	4.2 %	10.5 %
253	A	2.4 %	12.9 %
1050500015	A	2.2 %	15.1 %
1020240003	A	2.0 %	17.0 %
1020241336	A	1.7 %	18.7 %
136	A	1.6 %	20.3 %
190	A	1.6 %	21.8 %
151	A	1.5 %	23.4 %
154	A	1.5 %	24.9 %
199	A	1.4 %	26.2 %
254	A	1.4 %	27.6 %
1020241039	A	1.4 %	29.0 %
1020234050	A	1.3 %	30.2 %
1020221069	A	1.2 %	31.5 %
1020240006	A	1.2 %	32.7 %
218	A	1.2 %	34.0 %
15	A	1.2 %	35.1 %
17	A	1.2 %	36.3 %
182	A	1.2 %	37.5 %
120	A	1.2 %	38.7 %
1020234048	A	1.1 %	39.8 %
225	A	1.1 %	40.9 %
1020234045	A	1.1 %	42.0 %
1020236009	A	1.1 %	43.1 %
1020236009	A	1.1 %	43.1 %
1020234062	A	1.0 %	44.1 %
59	A	0.9 %	45.0 %
1020240005	A	0.9 %	46.0 %
1020234029	A	0.9 %	46.9 %
1020241379	A	0.9 %	47.8 %
267	A	0.9 %	48.6 %
269	A	0.9 %	49.5 %
1020234044	A	0.8 %	50.3 %
1020241054	A	0.8 %	51.2 %
1020241427	A	0.8 %	52.0 %
1020234046	A	0.7 %	52.7 %
1020236007	A	0.7 %	53.4 %
1020241006	A	0.7 %	54.1 %
191	A	0.7 %	54.8 %
1020241287	A	0.6 %	55.4 %
223	A	0.6 %	56.0 %
1020241381	A	0.6 %	56.6 %
260	A	0.6 %	57.1 %
268	A	0.6 %	57.7 %
110	A	0.5 %	58.3 %
1020241047	A	0.5 %	58.8 %
270	A	0.5 %	59.3 %
52	A	0.5 %	59.8 %
1020241132	A	0.5 %	60.4 %
156	A	0.5 %	60.8 %
235	A	0.5 %	61.3 %
1020234059	A	0.5 %	61.8 %

153	A	0.5 %	62.3 %	1020235030	A	0.3 %	72.9 %
155	A	0.5 %	62.7 %	168	A	0.3 %	73.2 %
1020233018	A	0.4 %	63.2 %	1020241402	A	0.3 %	73.5 %
1020241008	A	0.4 %	63.6 %	18	A	0.3 %	73.8 %
124	A	0.4 %	64.0 %	1020241440	A	0.3 %	74.1 %
72	A	0.4 %	64.5 %	1020240004	A	0.3 %	74.4 %
1020233017	A	0.4 %	64.9 %	1020241246	A	0.3 %	74.7 %
1020241230	A	0.4 %	65.3 %	1020241345	A	0.3 %	75.0 %
1020241231	A	0.4 %	65.8 %	1020241430	A	0.3 %	75.3 %
1020236008	A	0.4 %	66.2 %	1020241264	A	0.3 %	75.6 %
1020241263	A	0.4 %	66.6 %	152	A	0.3 %	75.9 %
1020234061	A	0.4 %	67.0 %	1020241429	A	0.3 %	76.1 %
214	A	0.4 %	67.4 %	221	A	0.3 %	76.4 %
1020241024	A	0.4 %	67.8 %	1020234060	A	0.3 %	76.7 %
160	A	0.4 %	68.2 %	135	A	0.3 %	76.9 %
122	A	0.4 %	68.6 %	14	A	0.3 %	77.2 %
134	A	0.4 %	69.0 %	16	A	0.3 %	77.5 %
183	A	0.4 %	69.4 %	83	A	0.3 %	77.7 %
4	A	0.4 %	69.7 %	105	A	0.3 %	78.0 %
3	A	0.4 %	70.1 %	1020241258	A	0.3 %	78.2 %
1	A	0.4 %	70.5 %	1020235025	A	0.3 %	78.5 %
99	A	0.4 %	70.8 %	61	A	0.2 %	78.7 %
56	A	0.4 %	71.2 %	1020241023	A	0.2 %	79.0 %
239	A	0.3 %	71.5 %	21	A	0.2 %	79.2 %
63	A	0.3 %	71.9 %	1020241401	A	0.2 %	79.5 %
1020224068	A	0.3 %	72.2 %	1020235016	A	0.2 %	79.7 %
6	A	0.3 %	72.6 %	60	A	0.2 %	79.9 %

According to the ABC analysis data, Company A sold a total of 402 products to the client company during the year 2021. A total of 106 products falls into the A category, which accounts for 80% of total sales revenue and 26,4 percent of inventory. There are 122 goods in the B category, which accounts for 15% of sales revenue and 30,3% of inventory. Finally, 174 products fall into the C category, which generates 5% of revenue and accounts for 43,2% of inventory.

A
- 106
- 80% of the sales revenue
- Apporoximately makes up 26,4% of the inventory

B
- 122
- 15% of the sales revenue
- Approximately 30,3% of the inventory

C
- 174
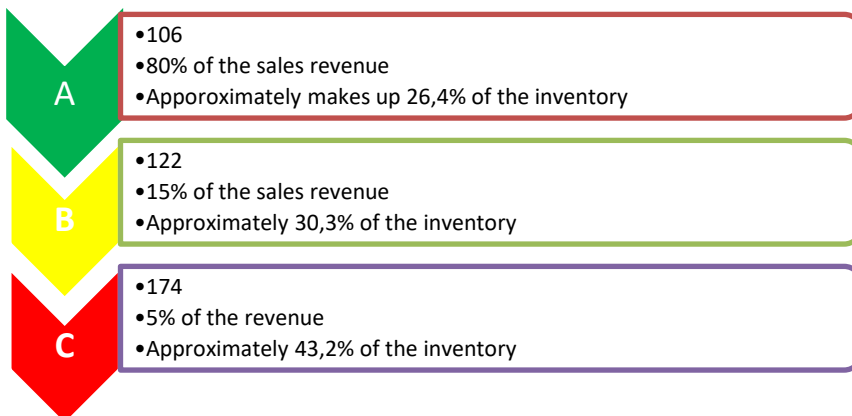- 5% of the revenue
- Approximately 43,2% of the inventory

Figure 9. Company A sales revenue ABC data

4.2.2 Company A sales amount

The top products that generated the highest sales amount in the year 2021 for company A are displayed in the table below, like the sales revenue results above. These goods are in the "A" category, which means that they account for 80% of total sales. Again, the writer was able to extract the precise ABC analyses necessary for the study by following the methods mentioned in the third chapter on methodology in the qualitative research technique, which comprised data collecting, and by utilizing the client company's ERP System.

Table 7. Company A sales amount A listers

Code	ABC	Percentage %	Cumulative %
1020241039	A	10.6 %	10.6 %
1020241054	A	10.6 %	21.2 %
1020241381	A	8.8 %	30.0 %
253	A	6.7 %	36.7 %
254	A	5.3 %	42.0 %
1020221069	A	4.9 %	46.9 %
260	A	4.0 %	50.9 %
1020241047	A	2.8 %	53.7 %
1020241006	A	2.8 %	56.5 %
124	A	2.7 %	59.2 %
1020233017	A	1.6 %	60.8 %
1020233018	A	1.6 %	62.3 %
1020241038	A	1.6 %	63.9 %
231	A	1.4 %	65.3 %
136	A	1.4 %	66.7 %
120	A	1.4 %	68.1 %
1020241259	A	1.4 %	69.5 %
234	A	1.3 %	70.8 %
1020241010	A	1.2 %	72.0 %
1020240003	A	1.2 %	73.2 %
1020233003	A	1.1 %	74.3 %
110	A	1.1 %	75.4 %
1020241263	A	1.1 %	76.4 %
1020241291	A	1.1 %	77.5 %
1020233009	A	0.8 %	78.3 %
1020241058	A	0.8 %	79.1 %
1020233008	A	0.7 %	79.8 %

According to the ABC analysis data and as mentioned earlier, Company sold a total of 402 products to the client company in 2021. The A category has a total of 27 goods, accounting for 80% of total sales amount and 6,7 percent of inventory. The B category has 72 products, accounting for 15% of total sales amount and 17,9% of inventories. Finally, 303 goods fall into the C category, which generates 5% of the total sales amount and accounts for 75,4% of the inventory.
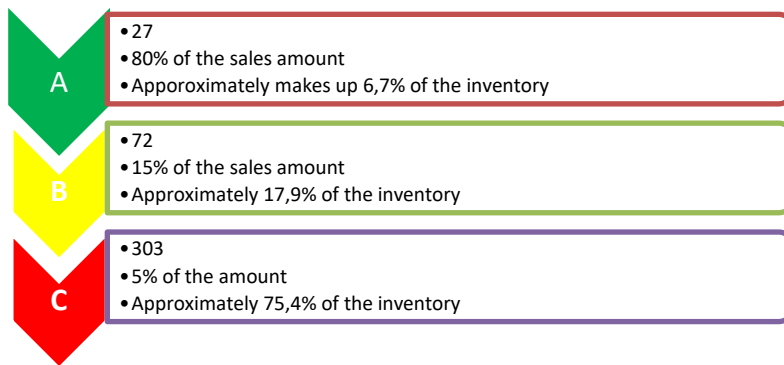
A
- 27
- 80% of the sales amount
- Apporoximately makes up 6,7% of the inventory

B
- 72
- 15% of the sales amount
- Approximately 17,9% of the inventory

C
- 303
- 5% of the amount
- Approximately 75,4% of the inventory

Figure 10. Company A. Sales amount ABC data

4.2.3 Company A Double ABC Analysis result

The table below lists the 18 most popular and highest-earning goods in the "AA" category. Because financial information is sensitive, it has been hidden. These findings were obtained by following the methods outlined in the third chapter on methodology. They were as follows: data collection, determining the items with large sales amounts, calculating their percentage, sales revenue calculations, and categorizing the products into the "AA" categories and so following Rudberg's double ABC analysis theory discussed in the theory chapters.

Table 8. Company A "AA" listers

Code	ABC revenue	Percentage %	Cumulative %	ABC amount	Percentage %	Cumulative %	Double ABC
1020241010	A	4.2 %	10.5 %	A	1.2 %	72.0 %	AA
253	A	2.4 %	12.9 %	A	6.7 %	36.7 %	AA
1020240003	A	2.0 %	17.0 %	A	1.2 %	73.2 %	AA
136	A	1.6 %	20.3 %	A	1.4 %	66.7 %	AA
254	A	1.4 %	27.6 %	A	5.3 %	42.0 %	AA
1020241039	A	1.4 %	29.0 %	A	10.6 %	10.6 %	AA
1020221069	A	1.2 %	31.5 %	A	4.9 %	46.9 %	AA
120	A	1.2 %	38.7 %	A	1.4 %	68.1 %	AA
1020241054	A	0.8 %	51.2 %	A	10.6 %	21.2 %	AA
1020241006	A	0.7 %	54.1 %	A	2.8 %	56.5 %	AA
1020241381	A	0.6 %	56.6 %	A	8.8 %	30.0 %	AA
260	A	0.6 %	57.1 %	A	4.0 %	50.9 %	AA
110	A	0.5 %	58.3 %	A	1.1 %	75.4 %	AA
1020241047	A	0.5 %	58.8 %	A	2.8 %	53.7 %	AA
1020233018	A	0.4 %	63.2 %	A	1.6 %	62.3 %	AA
124	A	0.4 %	64.0 %	A	2.7 %	59.2 %	AA
1020233017	A	0.4 %	64.9 %	A	1.6 %	60.8 %	AA
1020241263	A	0.4 %	66.6 %	A	1.1 %	76.4 %	AA

Table 9. Double ABC analysis result Company A

AA	18	High revenue High Sales amount
AB	31	High Revenue, Moderate Sales amount
AC	57	High Revenue, Low Sales amount

BA	9	Moderate Revenue, High Sales amount
CA	0	Low Revenue, High sales amount
BB	24	Moderate Revenue, Moderate Sales amount
BC	88	Moderate Revenue, Low sales amount
CB	17	Low Revenue, Moderate sales amount
CC	158	Low Revenue, Low Sales amount

The table above displays the nine double ABC classifications, followed by the number of products inside each classification, with AA having the highest sales revenue and the largest sales amount, and CC having the low revenue and sales amount. After obtaining this information, it was feasible to show to the client company which items may be maintained in the warehouse for stock and which products might be put on MTO.

5 DISCUSSION

The aim of the study is to help the client company to find out how they can optimize the inventory for selected products and still maintain a good customer service level. In this chapter the results of the study are analyzed in connection with the theories that has been brought up during the research such as ABC analysis, Double ABC analysis and the Pareto rule. This chapter presents the discussion of the results. In addition to the discussion of the results, conclusion, limitation, and recommendation for further research are presented.

Firstly, it shows that using the ABC analysis method is the best method to figure out a way to get the expected results for the study. As it is close to impossible to perform ABC analysis at client company's system due to number of products that have duplicated code or codes that is being used for the same product categories, the researcher has then decided that gathering data from companies A and B and perform a reverse ABC analysis will be the best solution. Using the said method, the researcher was able to observe two different cases in two different companies that are involved in the research in parallel. With the use of ABC analysis, the researcher was able to find out the exact position of the products in companies A and B with regards to their sales revenue and sales amount that they are selling into the client company. The fact that the exact position of the

products was found is a good thing for the research, this shows that there is a positive road ahead in identifying the important products in the client company, thus making way for the research to move forward.

Secondly, with the help of double ABC analysis, the researcher was able to achieve more conclusive result that points out to answering the research questions given during the start of this research; *What products should be kept in the warehouse? What products should be produced on order?* Double ABC analysis results was achieved by running parallel ABC analyses for the company A and for the company B. with this, the researcher was able to point out products have the high revenue and high sales amount to the products that have low revenue and low sales amount.

Pareto Analysis or the 80/20 rule played a significant role in the research. For the researcher to clearly see the general picture of the results Pareto principle was used as a tool by the researcher to confirm if the performed ABC analysis is correct.

Lastly, these theories mentioned above went hand in hand for the research to come up with the results. Pareto analysis and ABC analysis affected each other in a way that the basis for ABC analysis is the pareto 80/20 rule. The Pareto rule helped the confirmation of the results in which the ABC analysis have come up with. ABC analysis has major effect in coming up with the double ABC analysis results in which ABC analysis of the sales amount and sales revenue of the products are taken and ran in parallel using certain Microsoft Excel's function to come up with the final double ABC analysis results.

5.1 Discussion of the result

Given the non-disclosure policy of the research the researcher can only present certain information about the result. The results that have been found out were based on client company's 2020 yearly results.

5.1.1 RQ; What products should be kept in the warehouse?

As a result, based on the double ABC analysis, for the company A; products that fell into the categories AA; High revenue High Sales amount, AB; High Revenue, Moderate Sales

amount, BA; Moderate Revenue, High Sales amount, CA; Low Revenue, High sales amount are the products that have the possibility to be kept in the warehouse. Note that there are total of 58 listed products in the given table below, some of these products might already be in the warehouse as stocked product, therefore there will be lesser number of new products that will be newly stored in the warehouse.

Table 10. What products Should be kept in the warehouse? Company A

AA	18	High revenue High Sales amount
AB	31	High Revenue, Moderate Sales amount
BA	9	Moderate Revenue, High Sales amount
CA	0	Low Revenue, High sales amount

Like the above results, company B's double ABC analysis, the products that fell into the categories AA High revenue High Sales amount, AB High Revenue, Moderate Sales amount, BA Moderate Revenue, High Sales amount, CA Low Revenue, High sales amount. These are the products that have the possibility to be kept in the warehouse. There are total of 49 products listed below in which most of them are already in the warehouse which means that there will be lesser number of products that will newly be introduced to the stock.

Table 11. What products should be kept in the warehouse? Company B

AA	9	High revenue High Sales amount
AB	11	High Revenue, Moderate Sales amount
BA	9	Moderate Revenue, High Sales amount
CA	1	Low Revenue, High sales amount

It has been observed by the researcher that Company B's products takes time to deliver into the client company due to the geological distance and the data gathered pointed out that most of the company B's products are potential products to be stored in the warehouse to buffer times of the products due to the transportations.

The product categories mentioned above should not be kept in the warehouse with high amount of stock. This is due to the reason that ordering these products too seldom will lead to big volume orders and will have a probability to lose the optimum stock level in

the warehouse. Therefore making orders often of these products will keep the optimum stocking balance in the warehouse.

5.1.2 RQ 2: What products should be produced on order?.

Given the nature of the products being produced by both companies A and B to the client company to sell forward. There are products that is not just feasible to be in stock due to their characteristics.

Company A has more of these products. These Company A products can be produced on order as it will potentially reduce the space used in the warehouse. In addition to this, company A is located at the same compound as the client company. Made To Order (MTO) is the best solution as there is no buffer time in transportation of the products.

Company B's products that fell into the BB downwards to CC including AC categories are the products that can be put into MTO. Since they are the products that are more probably will just be sold less often during the year, these products will give more room to the products that have potential to be in the warehouse.

Notice that AC products falls into MTO; this is because even though these products are high revenue products, their sales amount is not enough for them to be added in the warehouse. And going back to Baily, P. et al., 2015, as stated in their constructive approach in stock reduction, there is no need to stockpile these products so that they will be there when needed. These products will just be fine to be manufactured to order if accurate forecasting and planning could be done.

Table 12. What products should be put on MTO. Company B

AC	19	High Revenue, Low Sales amount
BB	24	Moderate Revenue, Moderate Sales amount
BC	88	Moderate Revenue, Low sales amount
CB	17	Low Revenue, Moderate sales amount
CC	158	Low Revenue, Low Sales amount

5.2 Discussion of method

This research was conducted using Bryman and Bell's six-step qualitative research method for conducting qualitative research, see figure. 5. The objective of the study was achieved according to the researchers' standards and the methodology could be followed successfully from the start to the end. The six steps of Bryman and Bell gave the researcher a better basis to collect the data in a step-by-step method and deepened the research results into data and knowledge.

The data collection was successful, thanks to the client company's kindness in giving out the needed data and allowing the researcher free access to their data system. It provided the research with a solid foundation from which reliable results could be obtained. Due to the nature of the research and going back to the aim of the study, it was only right to not look into the entire warehousing data.

The researcher had some difficulty in the data gathering at first since there were products in the client company that have been uncoded or few products were under the same code in which made the data analysis confusing at first. Further investigation of the client company's coding system is strongly encouraged, in order to possibly make it easier for similar research to be carried out successfully and easily. Additionally, it will help the client company to identify their products effortlessly. This will be helpful for the client company's teams who are responsible for identifying these products.

6   CONCLUSIONS

The aim of the research is to help the client company to find out how they can optimize the inventory for selected products and still maintain a good customer service level. The purpose was that the client wants to find out an economically efficient way to have their product in their supply chain. The two main questions in this research are what are the products that should be put in stock and what are the products that should be put on MTO (Make to order).

As a result, based on the analysis that has been done in this research the client company has a chance to optimize their inventory for the selected products that are included in this research. This will maintain the expected customer service level and will not make any major changes in the said area.

As an answer to the first research question given. Based on the result of this research there are total of 188 products combined from companies A and B that can potentially be put on the warehouse for stocking. However, some of the products in these 188 products are already in the warehouse, therefore the products that are not yet in the warehouse should be identified and listed to make the said changes. However, based on the conversation between the client company and the researcher about the results, it has been noted that most likely that most if not all of company A's product will be put into MTO.
 Secondly, the research question *What are the products that should be put on MTO (Make to order)*. The results based on the analysis performed in this research showed that there are number of products that falls onto answering this question. However, there are products given their respective nature, they also fall into answering this research question. Initially from Company B; there are potentially 135 products that falls into MTO but in addition, most of the company A products as mentioned, given the product nature and the geological location of company A, most of its products will also be an MTO.

Perhaps if the time is not limited for this research and if done full time, every single product identification can be done to get more specific answer to the research questions and have a clear view on what exactly goes to which category.

6.1 Limitations of the study

The study was carried out to the expectation of the researcher given the time amount put in this research and other factors there was.

With that said, the issue came down during the start of the data gathering. There are products in the client company's system that falls onto the same codes, the so-called X codes. If those products have been coded properly, perhaps the data gathering wouldn't be so confusing as it is, and the identification of every single product will be easier. Lastly, due

to the time and resources given, the research is short and there could have been more to take from the given results.

The MTO and MTS products has been Identified as a result in this research but not the order stock volumes. The next step for the client company would be to plan the MTS (Make to stock) orders. How much to keep in stock and how often the products should be ordered. This will be important because this will eliminate the risk of overstocking and understocking.

6.2 Suggestions for further studies

For further studies regarding similar research subject, there is definitely room for further studies.

The Client company will have the need to calculate the optimal quantity for the make to stock products. Perhaps in a more focused study, with the combination of specialized focus, economical and time abundance, it will be helpful for the research to come up with the results to its minute details.

Lastly, given that the product coding issue has been brought up. It would be helpful for the client company to put resource into looking into these product code issue as it might be useful for their daily operations.

REFERENCES

Baily, P. et al., 2015 *Procurement principles and management 11th ed*,

Bragg, S., 2021. ABC analysis definition. *AccountingTools*. Available at:
https://www.accountingtools.com/articles/abc-analysis.html [Accessed October 4,
2021].

Bryman, Alan, and Emma Bell. *Business Research Methods. 3rd ed.,* Oxford, Oxford
University Press, 2011.

Bryman A. (2011). Business Research Methods. (3rd ed.), Oxford: OUP.

Ims-productivity.com. 2021. *ABC/Pareto analysis*. [online] Available at:
<https://www.ims-productivity.com/page.cfm/content/ABCPareto-analysis> [Ac-
cessed 20 October 2021].

Grant, D.B., 2006. *Fundamentals of Logistics Management*, London etc.: McGraw-Hill.

Hayes, A., 2021. *Inventory Management Definition.* [online] Investopedia. Available at:
https://www.investopedia.com/terms/i/inventory-management.asp[Accessed 12
January 2022].

HAYES, A. and JAMES, M., 2020. *Make to Order (MTO): Everything You Need to
Know*. [online] Investopedia. Available at: <https://www.in-
vestopedia.com/terms/m/make-to-order.asp> [Accessed 19 January 2022].

Kenton, W., 2021. *How Pareto Analysis and the 80/20 Rule Work*. [online] In-
vestopedia. Available at: <https://www.investopedia.com/terms/p/pareto-analy-
sis.asp#citation-1> [Accessed 2 November 2021].

Leon, S., 2016. *Financial intelligence for supply chain managers*. Old Tappan, N.J.:
Pearson Education.

Luenendonk, M., 2021. *A Complete Guide to ABC Analysis in Customer Segmentation
and Inventory.* [online] Cleverism. Available at: https://www.cleverism.com/com-
plete-guide-abc-analysis-customer-segmentation-inventory/ [Accessed 20 October
2021].

Mangan, J., Lalwanis, C. and Calatayud, A., 2020. *Global logistics and supply chain
management.* 4th ed. Wiley.

Muller, M. (2018) Essentials of Inventory Management. [edition missing]. HarperCol-
lins Leadership. Available at: https://www.perlego.com/book/728064/essentials-
of-inventory-management-pdf (Accessed: 25 September 2021).

Murphy, P. and Knemeyer, A., 2017. *Contemporary Logistics, Global Edition*. Harlow, United Kingdom: Pearson Education Limited, pp.150 - 154.

Nikolakopulos, A., 2019. Advantages and Disadvantages of ABC Analysis Inventory. [online] Small Business - Chron.com. Available at: https://smallbusiness.chron.com/advantages-disadvantages-abc-analysis-inventory-34202.html [Accessed 20 October 2021].

Prokopenko, J. and North, K., 1997. *Productivity and quality management.* Geneva, Switzerland: International Labour Office.

Rudberg, M., 2016. [online] *Artikelklassificering.* Available at: <https://files.abcsoftwork.com/embed/articles/abc_item_classification_se> [Accessed 31 October 2021].

Siemens Digital Industries Software. 2022. What is make-to-stock (MTS) | Siemens Software. [online] Available at: https://www.plm.automation.siemens.com/global/en/our-story/glossary/what-is-make-to-stock-mts/100404[Accessed 13 January 2022].

Smirnov, Y., 2018. ABC Analysis of Inventory | Definition | Pareto Principle | Example | Advantages and Disadvantages. [online] Financialmanagementpro.com. Available at: http://financialmanagementpro.com/abc-analysis/[Accessed 31 October 2021].

Storhagen, N., 2011. *Logistik*. Malmö: Liber.

Truong, H., 2021. *ABC Inventory Analysis Method - Benefits and Limitations.* [online] Zipinventory.com. Available at: https://zipinventory.com/en/inventory-count/abc-inventory.html[Accessed 2 November 2021].

Waters, D., 2003. *Logistics: An introduction to supply chain management*, Basingstoke: Palgrave Macmillan.

Yin, R.K., (1984). *Case Study Research: Design and Methods.* Beverly Hills, Calif: Sage Publications.